CHAPTER 1

PRESERVATION OF HIDES AND SKINS

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THEORY OF HIDE AND SKIN PRESERVATION

The purpose of curing a hide or skin is to temporarily preserve it from the time it is removed from the animal until it can be processed into a final product. In the case of cattle hides the most important final product, in terms of value, is leather. By definition, curing is a temporary treatment of the hide so that microorganisms cannot break it down for food, and thus damage it.

Tanning can be defined in a similar fashion because once a hide is tanned it is no longer subject to breakdown by microorganisms. However tanning differs from curing in that most tanning processes produce a permanent change in the hide that converts it into a useful product, leather. Curing is designed to be temporary so that various end products can be manufactured from the raw hide. In addition to leather, products such as gelatin, sausage casings and cosmetic ingredients can also be produced from raw hides. Whilst most tanning processes, such as chrome tanning and vegetable tanning, are relatively permanent, others such as alum tanning, often used by taxidermists, may be washed out. When a temporary tanning agent is removed from the hide it is once more subject to microbial attack.

All parts of an animal are subject to decay after death. The hide is no different from muscle tissue (meat) or any other part of the animal. If something is not done very soon after slaughter to preserve the hide, it will very rapidly begin to decay. While meat is generally kept refrigerated for short term preservation and frozen for long term preservation, hides in this country (USA) and most others are generally preserved by curing with salt. Curing in this case is just another word for temporary preservation.

The Need to Preserve:

There are two identifiable factors which could cause a hide to become unsuitable for leather making, they are bacterial decay and autolysis. The key to both these factors are enzymes.

The skin of an animal is an organ in the same sense that a liver or kidney is an organ. An organ is a system of tissues which perform a specific set of functions for an organism. The skin is the largest organ of the body and comprises of 3 to 5% of an animal's weight. The skin performs many functions, protection against physical injury, a barrier to microorganisms, protection from the elements, and against drying out, it even helps to regulate body temperature.

Examination of the cross-section of a hide (Fig. 1) shows that there are basically two major divisions: the epidermis or grain layer and the corium. The aesthetic

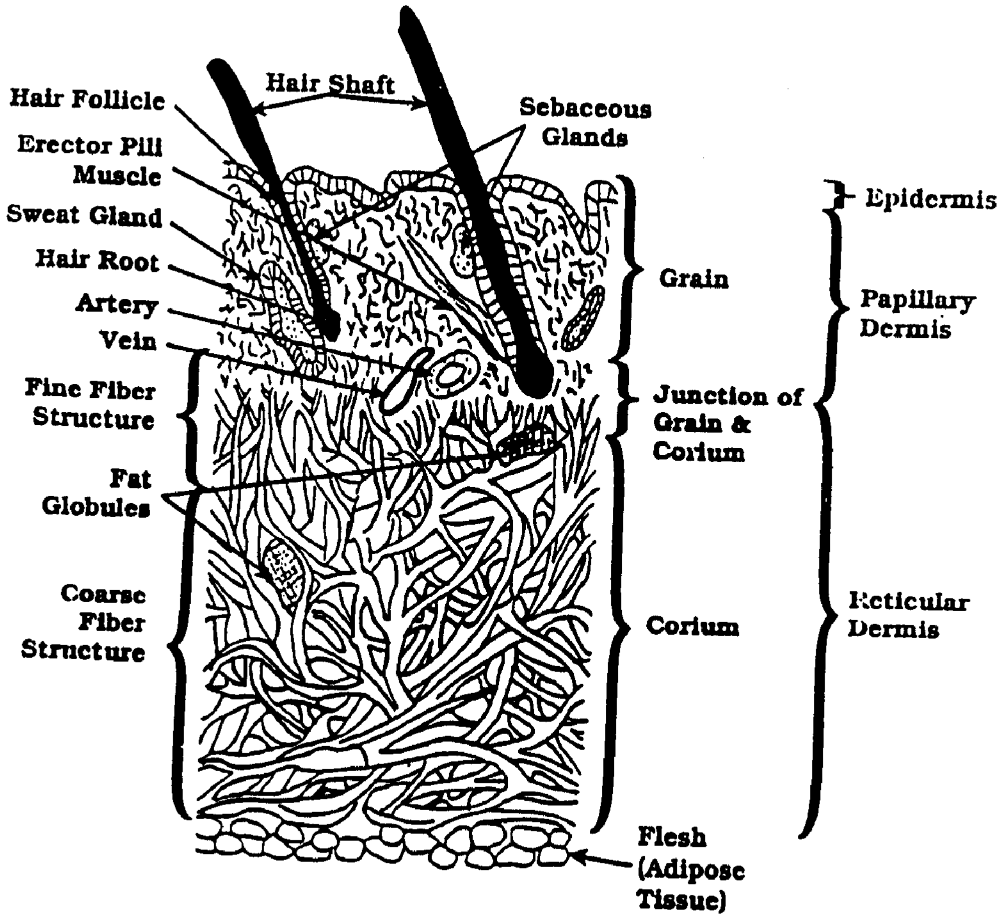

Figure 1. Schematic Diagram of the Cross-section of Cattle Hide.

value of leather is derived from the grain. The corium gives leather its strength and resiliency. Individual collagen molecules in the corium combine to form fibrils that are in turn bound together to form collagen fibers which are visible under the microscope. The strength of skin and leather produced from it is due to cross weaving of these fibers.

Another fundamental property of the skin is that it is a barrier to microorganisms. This barrier to microorganisms is more than just a mechanical process. When an animal dies, microorganisms begin to penetrate the skin within hours and begin to multiply rapidly in the nutritious environment inside the skin. The skins of all animals are naturally covered with bacteria. In the case of a cow or a steer the hide is a particularly rich source of a wide variety of organisms. Soil contains a large variety of species of microorganisms as does manure, both of which are usually present in large quantities on the surface of a bovine skin. After death bacteria on the hide produce enzymes which can eventually digest the hide completely.

Autolysis is of less concern to the hide processor. This is a process by which the enzymes present in an animal's own cells can break down tissue. They are not active as long as the animal is alive but can start the breakdown process *post-mortem*. It is a natural part of an animal's defense mechanism against injury. Almost any kind of injury causes some cells to die, for the wound to heal the dead cells must be dissolved and this is done by enzymes present in the cells. Many of the same factors, such as cold or high salt concentrations that control bacteria will also slow down or prevent the autolytic enzymes from breaking down the hide. The quantity of autolytic enzymes does not increase with time as do bacterial enzymes.

Bacterial Growth

To understand curing you need to understand something about how bacteria grow. Given a good food supply, many bacteria can divide every few hours, hide is a very good food supply. To get an idea of what it means to double every hour, if you started with a penny (cent) and double it every hour, at the end of the thirty hours you would have more than three and a half million dollars (364 million pennies).

Bacteria can only take in nutrients which are presented as small molecules. These an be absorbed directly into the bacteria, otherwise, bacteria have to break the ood down outside the organism using enzymes and then absorb the nutrients. Bacteria need water, an effective way to kill bacteria is to dry them out. Some acteria have adapted to very dry conditions and can form spores capable of eproducing many months or even years later when conditions for growth are roper again. In water, bacteria require a near neutral environment.

There are two kinds of bacteria, anaerobic or aerobic. What are the conditions equired for growth of bacteria? It turns out that they are very similar to the onditions we need to grow. We have already mentioned a good food supply, ey also like warmth (up to a certain point, the warmer it is the better they row). Keep in mind that there are many kinds of bacteria and what I am saying generally true but there are exceptions to almost every generalisation. emperatures near the temperature of boiling water will kill most bacteria but ome very specialised bacteria can grow even in the hot springs in Yellowstone ark and others have been found near natural hot springs on the floor of the cean. One difference between us and some bacteria is that some grow very pidly in the absence of oxygen, these are anaerobic bacteria (the ones that need xygen are the aerobic bacteria).

NON-SALT PRESERVATION

Now how do these characteristics of bacteria fit in with the way hides have been eserved for centuries, long before anyone was even aware that bacteria existed?

rying

The earliest form of preservation was drying. A completely dry hide or skin nnot be digested by microorganisms. Microorganisms need water to grow and multiply and produce enzymes. Enzymes need a wet environment to act as catalysts. Many bacteria that cannot tolerate dry conditions die while others go into a dormant stage until moisture is available again. This is one reason why, even when after a hide is thoroughly dried out and is apparently stable, if it becomes wet again it will rapidly decay.

It is much easier to dry skins than it is to dry hides. To obtain good leather from a dried skin the drying must be done properly. Skins that dry too fast on the outside can leave moist areas in the interior which will decay during storage. Sometimes the area under a beam or rope supporting the hide does not dry evenly producing an area which is partially decayed. Drying is more rapid in a thin skin than in a thick hide. It can only be done in areas which are consistently dry and warm. It is not a choice, for example, in England where the humidity is generally high and the temperatures are not.

Another disadvantage of drying alone is that although the skins are not subject to bacterial attack they will be subject to insect infestation which can cause just as much damage. The secret to dry preservation is that it is rapid and even throughout the skin. It is extremely difficult to dry a hide and keep it in good condition for leather making.

Bactericides

Microorganisms are of course easily killed by a variety of chemical poisons. Unfortunately, many of the best poisons for bacteria are also poisonous to humans and therefore, not good choices for treatment. There are two effective types of chemical treatments for bacteria-*bacteristats* which limit the growth of organisms at any stage and *bactericides* which kill the organisms outright. Both of these types of materials, at best, are good for short term preservation, that is, for a few days or a week. Because hides may often be in transport for far longer than this, short term preservatives have not found very much favor except to improve other long term preservation methods such as salt.

Many of the bactericides used in the past were based on mercury compounds or chlorinated phenols, both of these materials, while very effective, are detrimental to the environment and are no longer in use for this purpose. The substitute materials available on the market today are generally safer but may not be as effective.

Pickle Curing

With few exceptions microorganisms cannot survive in an environment which is very much lower than pH 5 or higher than pH 8, this factor has been taken advantage of for preservation by the development of pickled stock. The predominant commercial use of this is in sheepskins. The skins are held and shipped in an acid solution at a pH of between 2 and 3. This kind of preservation tends to make the final leather very soft and could only be considered for particular kinds of leather. Very long term storage will significantly weaken the leather. However as a means of bacterial control it is very effective.

Lowering Water Activity

Water activity is a measure of the availability of water to microorganisms in a particular environment. As already stated, bacteria need water to grow, without it they can at best only survive in a suspended state. It is possible to add chemicals to substances that contain water which will make the water just as unavailable as if you had removed it completely by drying. You are probably already familiar with commercial products of this type. The moist dog food products which don't have to be refrigerated have had chemicals added to them which makes the moisture in the food unavailable to bacteria for growth.

Salt curing acts to preserve hides by a combination of removing water from the hide and lowering the water activity of the remaining moisture. Salt curing goes one step further and tends to remove the water from any organisms on the hide effectively killing the organisms. This is true for all bacteria except for a particular class called the halophiles. Halophiles will be discussed later.

SALT CURING

Theory

How does salt move into the hide?—by diffusion, the spreading or diffusion of salt into the hide is very different depending on which side of the hide you are considering. Looking back at the structure of a hide, we have the epidermis or the grain layer on one side and the flesh side on the other. While the animal is living the skin presents a natural barrier to practically all substances including water and bacteria. Immediately after the death of an animal this barrier breaks down and bacteria begin almost immediately to penetrate the skin through the hair follicles and thus into the network of blood vessels. The fiber structure of the grain side of the hide is very compact and dense which prevents direct bacterial penetration for a long time but eventually, even this layer can be digested by proteolytic enzymes permitting further bacterial damage in the interior of the skin.

The other side of the hide is the flesh side. On a well fleshed hide there is little structure other than the fibers of collagen. Compared to the grain these fibers are much less dense and compact. As a result, during salt curing processes, most of the salt diffuses into the hide from this side—providing that the hide is well fleshed. Heavy deposits of fat on the flesh side of the hide slow down salt penetration. The salt must then migrate from the edges of areas of fat to get to the interior of the hide. If the hides are removed from the salt before curing is complete those areas of the hide will receive a poor cure. Over time these areas begin to deteriorate even while the other areas are well preserved.

Now we have to add a little more complexity to the problem. The water molecules in the hide act just like the salt molecules in the brine solution. The density of water molecules in the hide is greater than the density of water molecules in the brine solution outside the hide. So water molecules tend to move out of the hide by the same process of diffusion by which the salt molecules move in. Water is removed from the hide because of the osmotic effect of the strong salt solution and the salt solution becomes a little more dilute. The rule of thumb is that each hide loses one to two gallons of water during the brine curing process.

PRACTICE OF SALT CURING

Normally salt packs are usually discussed first when salt curing is discussed because it was historically the first method for preservation. However it is easier to explain the migration of salt into the hide by first discussing brine curing.

Brine Raceways:

A brine raceway generally looks like a round or oblong swimming pool with a concrete island in the center. One, and sometimes two, paddle wheels are mounted from the side of the raceway to the island to keep the brine and the hides in brisk motion during curing.

Brine raceways are designed to do several things. First, a very large float is used which helps the raceway maintain a high salt concentration even when the fresh hides are removing salt and adding water to the raceway, secondly they are constructed to keep the hides suspended with some kind of mechanical action while allowing freedom of movement of the hides within the brine. The "float" is a measure of the ratio of water to hides by weight (100% float means that the weight of water equals the weight of the hide.) The generally accepted rule used to be that raceways require a minimum of 4 pounds of saturated brine per pound of green hide for good curing. This is equivalent to a 400% float equivalent to 40 gallons of brine for each hundred pounds of hides. Many raceways are used at a much lower float today and this does affect the degree of cure.

In considering the raceway cure, mechanical action is very important. The movement and flexing of the hides during curing in a brine raceway lowers the time needed to reach a final equilibrium. The brine is usually moved in circular direction around the raceway with a paddle wheel. If the motion is too slow the hides tend to sink and settle to the bottom and do not receive a proper cure.

In addition to physical action curing is affected by temperature. As the temperature decreases salt penetration slows and reaching a proper cure requires more time. In general salt curing is quicker in the summer than in the winter unless the raceways are heated. More information on the effect of mechanical action and temperature on hide curing is described in a paper by Bailey and Wang[1].

A difficulty which occurs in brine raceways in which the brine is not regularly changed is the deposition of dirt and manure in the bottom. Because the brines are being used continuously, the dirt tends to accumulate to the point where it can significantly lower the volume of the raceway and therefore the float ratio in which the hides are being treated. A lower float causes the salt concentration to decrease rapidly as salt is taken up into the hide.

A full cure in a normal float requires about 18 hours. If the high salt concentration difference between the water in the hide and the raceway is reduced by the low float, then the rate of movement of salt into the hide is slowed down. Hides pulled in 18 hours, under these conditions, may not be fully cured. Another curing problem that may occur in a brine raceway is due to the fact that it is a batch process. That hides are not removed from the vat in the same order that they are put in. The last ones in could be the first ones out. It is possible that hides added to the raceway during the day could be pulled from the raceway in less than 16 hours. This will mean that these particular hides will be under cured and could present a problem in long term storage.

The lixator is designed to overcome the dilution of the brine. Brine solution from the raceway is continuously pumped into a separate container filled with dry salt. As the salt solution percolates through the salt it dissolves more salt and increases the concentration of salt in the raceway. This maintains a high level of salt in the raceway which makes the transfer of salt into the hides more rapid and allows it to reach a higher level than it would if the salt was not replaced.

Salt Packs:

Salt packs are the easiest method of curing with salt. In this process the first hide is placed on a bed of salt, it is then covered with salt and the next hide placed on top. It requires about a pound of salt per pound of hide to be cured to do a thorough job of curing. The type of salt used is important too. A medium grade of rock salt is usually used. This dissolves in the hide more evenly and the excess can be more readily removed when curing is complete. Fine salt, like table salt, tends to form a hard cake as water begins to be removed from the hide and this cake interferes with further water removal and salt uptake.

The principle of solid salt curing is the same as brine curing. Only in this process the dry salt dissolves in the water already in the hide. Water inside the hide tends to migrate out of the hide and the salt moves to the inside. This process is much slower than brine curing and takes as much as thirty days to complete. It is not as commonly used as it once was and it is not used by any major U.S. packers today. The high capital investment required to purchase hides makes a thirty day storage period before they can be shipped very unattractive. The full thirty days are required to fully drain the hides so that further seepage during shipment will be minimal.

Historically the best known salt cure in the history of hide trading was known as the "Frigorífico". In this process, developed in South America, the hides were first salt pack cured for thirty days in a vat. Then the vat was filled with saturated brine solution for another period of time before they were drained. This process took a long time to complete but they were considered the best cured hides in the world at the time.

Hide Processor or Mixer Cure

The third method of salt curing, the hide processor or mixer cure, is the fastest. This is because the greater mechanical action which takes place in the mixer speeds up the penetration of the salt and the removal of water. Hides should be fleshed for this type of cure. The recommended procedure may vary among hide establishments, but this is one that seems to produce a quality product using a hide processor. The processor is filled about one third with brine and 24 000 lbs of fleshed, trimmed hides are added. Additional brine is then added to bring the float right to the top. The hides are turned 5 minutes every thirty minutes. Every two hours salinometer readings are taken and salt is added to bring the reading up to 80% saturation. A sanitizing agent is also added to help keep the bacteria level in the brine as low as possible. Overnight it requires about a ton of salt, added as a solid, to obtain a full cure. The entire operation is monitored by measuring the brine solution as the curing proceeds. It's never the same from one batch to the next so a set pattern of additions of salt is not used.

GENERAL HIDE PROCESSING

The following steps make up the ideal procedure for curing cattle hides with salt. The procedure is pretty much the same for any kind of salt curing but the most widely used method is brine curing.

Washing. Hides should be washed right off the kill floor to remove blood, loose manure and to remove some heat from the hide. In a heavy manure season a short wash will do little to remove extremely heavy tag but it's a start.

Fleshing. After washing the hides should be fleshed to remove excess adipose tissue (fat) from the flesh side of the hide. This is important for good penetration of salt since neither water nor salt will penetrate into a layer of fat. Again, in a heavy manure season, in order to prevent damage to the hide from manure balls, the fleshing machine is backed off. The effect of this on the hides is a generally poorer cure.

Trimming. Before being placed in the raceway the hides are trimmed to remove the non-leather making portions of the hide. It is better to do it at this stage because the fleshings and trimmings can be rendered more easily in this condition than if they contain salt. The quality and value of fats and oils from rendering is considerably reduced if the salt content is too high.

Brine Curing. This was covered previously.

Wringing. If the hides are not wrung after curing they will drain for several days afterwards. Wringing rapidly removes the excess moisture from the hide not only reducing shipping costs but allows them to be shipped much sooner.

Inspection. After wringing, the hides are completely flat giving the hide dealer his last look at the entire hide. At this stage the hide is graded according to sex, appearance of brands, pattern of removal from the animal and any other defects that might be present.

Safety Salt. Immediately after inspection safety salt is often added to the hide to further insure that the salt content of the hide is close to saturation. Many packers and hide processors are eliminating the use of safety salt, particularly when the tanner buying the hides requests it. If the hides will be tanned fairly soon after curing the salt adds little to the curing but adds considerably to the salt in the effluent of the tanner.

Bundling. The hides are bundled as the safety salt is added and taken to a weighing table. At one time hides were bundled hair out if they were going to a domestic tanner and hair in if they were being exported. Today's convention depends on arrangements between the buyer and seller.

Storage. Storage of hides is best done in a cool, preferably dry area. Well salt cured hides may be stable for up to two years but sooner is always better. With the cost of hides today sooner is generally the rule.

ANALYSIS OF CURE:

Brine Cure Standard

The standards for properly salt cured hides are a moisture level between 40 and 48%, and a salt saturation of greater than 85%. This is considered the minimum standard for hides which will remain in good condition for extended periods of storage. There is some disagreement on how long salt cured hides are stable but under less than 70°F storage they should last at least a year. As the temperature of storage increases the stability decreases.

Comparison of Fresh and Brine Cured Hides:

Fresh Hide 100 lbs	*Brine Cured Hide 84 lbs*
60–64 lbs of Water	34–36 lbs of Water
36–40 lbs of Hide Substance	36–40 lbs of Hide Substance
	8–10 lbs of Salt

Moisture Content

The water content of a hide can be measured easily using a balance to weigh the hide sample before and after heating in an oven overnight. It is well established that when the moisture content rises above 48% the stability of the hide in storage decreases rapidly. Bacterial growth occurs causing damage to the grain and lowering the value of the leather made from that hide. It also adds weight and therefore increases the cost of shipping. If the moisture is too low, that is less than 40%, the hide will not re-hydrate properly during tanning. This results in a lower quality grain surface because the hide is not properly let out or stretched and the area yield of the leather may be reduced.

The procedure for the analysis of moisture and ash as described by Roddy[2] is simple and straight forward. There are two methods which give acceptable values and both will be described. Approximately 1 g. plugs are taken from the hide and the hair is clipped off and any flesh adhering to the other end is removed. A circular 1/4 inch plug is about the right size. The plug is weighed and then placed in a vacuum oven for 16 hours at 80°C. The oven contains phosphorous pentoxide to absorb the moisture given off by the sample. The plug is then re-weighed and the moisture calculated.

The percent moisture is equal to the difference in weight before and after heating (this is the weight of water removed by heating) divided by the starting weight of the plug.

Determination of moisture by this method takes about 24 hours. A newer method proposed by Lollar and Kallenberger[3] at Leather Industries of America Laboratory at the University of Cincinnati uses a microwave oven and reduces the length of time required to determine moisture content to less than 30 minutes. In this procedure a 10 g. sample of the hide is used. Again the hair and flesh are removed. The sample is put in a microwave and full power is applied in four applications, each separated by 2 minutes. The first application is 20 seconds and the following three are for 40 seconds each. The 2 min. separations are to allow the moisture to evaporate from the sample. Some additional variations are required for larger numbers of samples.

A word of caution on the oven heating method, if you run the temperature up too high, there is a danger of case hardening the sample. This means that the surface dries very rapidly and traps moisture inside which is not released during the drying period. This leads to low false moisture determinations.

Ash Determinations:

Saturation of salt is calculated from the moisture content and the ash content values for the hide. Ash determinations can be done on samples which have had moisture determinations done already, or on fresh samples. It is a similar determination to the moisture content except that the oven temperature is 600°C. This not only removes all of the moisture but all of the hide substance or organic matter leaving behind only the ash. In the case of salt cured hides this is almost entirely salt.

Ash determinations usually follow the moisture determinations on the same samples. The dry sample is placed on a pre-ignited container and weighed. The sample in the container is put into a muffle furnace and heated at 600°C for about five hours. After cooling the container is weighed again and the difference before and after heating is the weight of ash. The weight of the ash should be a minimum of 14% of the original weight of the sample for proper curing, providing the moisture content is in the correct range. The microwave oven technique cannot be used for ash determinations.

Calculations for salt curing

Saturated brine contains 35.9 grams of salt per 100 grams of water at 68°F.

$$\text{Percent Saturation of Salt} = [(\%\, \textit{Total Ash} \times 100 \,/\, \%\,\text{Moisture} \times 100) \,/\, 0.359] \times 100$$

Delayed Cure (staling) Test or Gelatin Film Test:

A good cure test does not guarantee that the cure was done well. A hide is mostly made of protein and when bacteria grow on a hide they produce proteases (proteolytic enzymes) which they excrete on the surface of the hide. Now, if a hide was not cured promptly and bacteria were allowed to grow on it for a period of time before curing, damage to the grain could already have occurred. This is called staling. The hide could then be cured properly and have the correct moisture and salt concentration. However the enzymes which were produced by the bacteria are still on the inside of the hide and the gelatin film test can be used to determine if they are still present[4].

Ordinary photographic film is coated with a layer of gelatin as a binder for the photosensitive chemicals. Gelatin is a protein derived from collagen and is readily degraded by proteolytic enzymes (proteases). Pieces of exposed film can be used to test for the presence of proteases. A drop of liquid is squeezed out of the hide sample being tested and placed directly on the gelatin film coating. At room temperature, if proteases are present, the gelatin will be dissolved within a few minutes. The test is at best semi-quantitative so that a little activity is distinguishable from a lot of activity. There are three layers of gelatin and under controlled conditions the number of layers of gelatin removed within a specific period of time determines the rating. If two or three of the layers are removed it is sufficient for the tanner to make a claim for poor cure.

Red heat—halophilic bacteria

Finally, one additional concern with brine cured hides is halophilic organisms, classically known as "Red Heat". Halophiles are bacteria that can grow in concentrated solutions of common salt, sodium chloride. They are widespread being found in salt lakes, salt mines and even in evaporated solar salt. The red color associated with these organisms has been found in almost all materials that are preserved with salt. It is well documented as a problem with salt curing of fish. The red color is due to a pigment produced by these bacteria. For many years these organisms have been associated with damage to the grain surface of the hide. It was felt that when they were visible there were probably other organisms present that actually did the damage. However, recent work[5,6] in the US Department of Agriculture Hides, Lipids and Wool laboratory has demonstrated that halophiles, under certain conditions, can damage a hide.

DISADVANTAGES OF SALT CURING:

While salt curing hides is a relatively easy and proven method to temporarily preserve them until tanning it also constitutes a considerable problem to many packers and tanners. The most difficult effluent pollutants to remove are dissolved solids. Brine or salt curing adds a considerable amount of dissolved solids to both the packer who cures the hides, and to the tanner whose first process at the tannery is an overnight soak to remove the salt from the hide in preparation for tanning. The level of difficulty caused by salt varies with the effluent treatment regulations in different parts of the world. However, in the future it can only become more difficult and as a result alternatives to salt are being actively sought by both packers and tanners.

GENERAL COMMENTS ON SALT

Common salt is not so common. For example there are one hundred and twenty different grades of salt available. All of these are derived from three types of salt, rock salt, vacuum pan and solar.

Rock salt is mined directly from salt domes. These are areas where prehistoric salt seas evaporated and all of the salt in the sea was concentrated into one location. Salt domes may extend as much as 21 000 ft deep and one mile wide. There are a number of salt domes around the world. The major impurity in mined salt is calcium sulphate but, when purchasing salt for hide curing, it is most important to be sure that there are no iron impurities that will stain the hides. Rock salt comes in coarse, medium and fine crystals.

Solar salt and vacuum pan salt are evaporated salts. That is they are produced by removing water from a concentrated salt solution. The salt lakes are a source of solar salt as are the oceans of the world. In these cases the salt water is pumped into large shallow lagoons and allowed to evaporate naturally under direct sunlight. Solar salt forms fine crystals when evaporated slowly.

Vacuum pan salts are generally produced from salt deposits deep in the earth. Water is pumped into a well next to salt deposit and it will find its way into the salt. The water dissolves the salt and is pumped back to the surface and dried in vaccum driers where it is crystallized under vacuum, filtered free from the remaining brine and dried in rotary kilns.

Salt is so inexpensive to produce that the major cost of purchasing salt is transportation which often exceeds the cost of the salt itself. This also makes the cost very sensitive to the volume purchased. Use of salt by the freight car load makes the cost considerably lower than using salt by the bag. Since transportation is a major factor, the further you are from the source of the salt the more expensive it becomes.

Preservation of cattle hides in a salt pack requires medium grade crystals. Fine crystals form dense cakes when they draw moisture out of the hide and can become effective moisture barriers preventing the full dehydration of the hide. Since fine salt is less expensive that course salt the former is used when salt is dumped directly into the brine raceway. If lixators are used to maintain salinity then the brine from the raceway should be pumped upward through the salt to prevent clogging.

Baumé and Density:

Water has a density of 1.0, a saturated brine has a density of 1.204. Thus a gallon (U.S.) of water weighs 8.33 pounds and the more dense gallon (U.S.) of brine weighs almost 10.03 pounds. The density of a salt solution is usually measured on the Baumé scale. A weighted hydrometer, or salinometer, is placed in the brine solution and the density in Baumé is read on the scale. Water is 0.000°Bé and saturated salt is 24.6. Tables are available which allow you to compare density, Baumé and percent salt by weight.

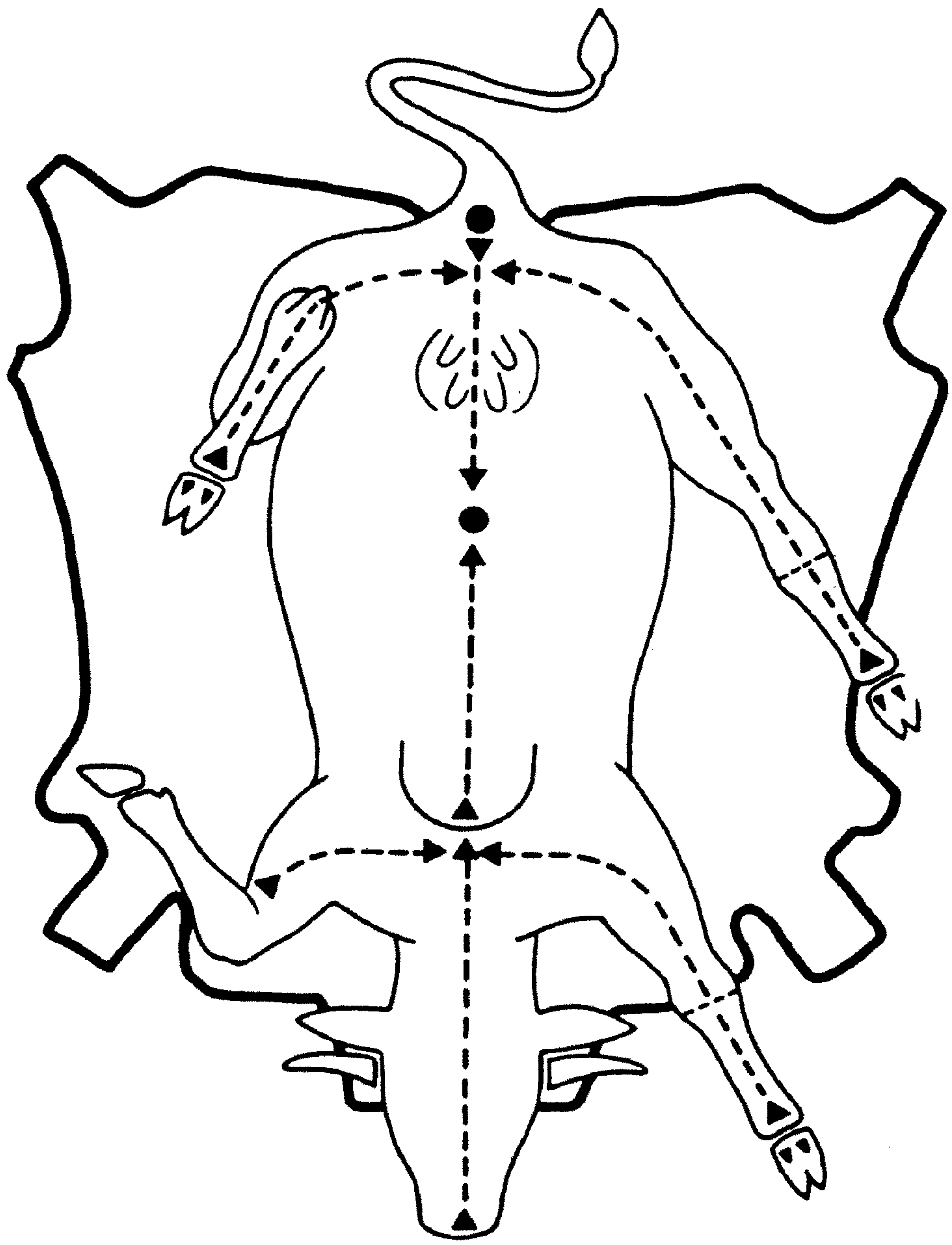

Figure 2. Standard Cattle Hide Trim Pattern taken from "Trade Practices for Proper Packer Cattlehide Delivery". Issued 1990 by Leather Industries of America and the U.S. Hide, Skin and Leather Association.

ALTERNATIVES TO SALT CURING

Currently available alternatives to providing the tanner with raw material for leather making include shipping fresh hides, that have been iced down and refrigerated, to a tanner within a few hours after slaughter. This permits a delay in processing of only one or at most two days. This alternative is only practical over relatively short distances. The most economically important alternative today is the processing of hides into "blue stock" right at the packing plant.

Since about 60% of the hides produced in the United States are exported, the use of fresh or refrigerated hides can only be used for the domestic market. Blue stock is a growing alternative for the export of hides and is the only commercially available process competing with salt cured hides at this time.

Research into new areas of hide preservation is continuing. These include chemical treatments with bactericides and irradiation—either electron beam or gamma. In addition a great deal of work has been done with an alternative to salt that closely resembles the current brine curing process. That is the substitution of potassium chloride for sodium chloride. The pros and cons of each of these methods follows.

Fresh Hides:

Domestically one of the most direct solutions to salt pollution for the tanner and the packer is to use fresh hides. The problem, which we discussed earlier, is that the hides rapidly deteriorate once they are removed and the tanning process must begin within twelve hours or less to prevent damage to the hide that will subsequently reduce the value of the final leather. This time constraint limit's the number of hides that can be processed this way because most of the packing houses are located more than twelve hours away from potential tanneries. In addition, in order to produce uniform leather, the tanner needs to begin with uniform hides. If he takes the entire day's production from the packer he is going to receive hides with a wide variety of categories, size and weights and so uniformity of product will be difficult to achieve. If all of the hides cannot go directly into leather production then the packer must still maintain his brine raceway.

Refrigerated Hides:

A one-step improvement from fresh hides are refrigerated hides. Here the hides are iced down immediately after they are removed from the animal and placed in insulated bins for shipment. They are then shipped in refrigerated trucks permitting delays in processing up to three days, this treatment extends considerably the distance these hides can be moved. One downside with this alternative is, of course, the expense of extra handling and refrigeration, in addition, the hides are still fragile and delays due to breakdowns in the transportation system or refrigeration could be very expensive. This extended time does however permit a better selection of hides for the tanner making it possible to obtain more uniformity in the leather product. But again, if the packer cannot send all of the day's kill to the tanner he must still maintain a brine curing facility. Refrigeration works very well where the hides are destined for more than one final product, i.e. leather and collagen casings when a portion of the added costs can be recovered.

Tanning to the Blue

Blue stock is the material produced after the addition of chromium tanning chemicals to the hide, it is the first stage where the hide is permanently preserved, the name is derived from the blue color. With further treatment in the retan, colour and fatliquor steps of the process the same starting blue stock can possibly be processed either into light soft garment leather or a firm heavy boot leather. Thus, blue stock can be used as a starting raw material by almost any tanner, in place of salt cured, or fresh hides. It is a relatively stable commodity that can be shipped anywhere in the world. The hides are removed from the animals and transported directly into the tanning area and processed within a few hours. There is no danger of hide deterioration occurring in the short interval between slaughter and tanning.

The blue stock alternative seems to be ideal and is growing in volume, however, up to this time it has not dominated the world market, but that may change soon because other major packers are gearing up to tan their own hides and produce blue stock. Against this, however, many tanners want more control of the final product by controlling the entire tanning process themselves. In addition they would prefer to keep the added value of tanning the raw hide themselves rather than paying someone else to do so.

The major advantage of buying blue stock for the tanner, rather than salted or fresh hides, is that his effluent pollution, and therefore his cost of effluent treatment is considerably reduced. As the rest of the world tightens their pollution regulations the volume of blue stock produced can only increase.

Bactericides:

Several companies are marketing chemical preservatives for fresh hides to preserve them for a week or more without refrigeration. These products are registered for fresh hides but I am not aware of any recent work demonstrating their use on fresh hides for periods of more than a few days. More work needs to be done to demonstrate these or perhaps other chemical products.

Electron Beam Irradiation:

This is a process in which I am particularly interested. This method produces a product with properties similar to a fresh hide, does not use any salt, and gives a product which can be stored indefinitely. Hides treated this way could be sorted and sold in categories in the same way salted hides are sold and salt pollution would be completely eliminated[7,8]. Once preserved the hides must remain in a sterile environment to prevent re-contamination with bacteria. Outside the package these hides would decay as rapidly as fresh hides just removed from the animal.

You are all familiar with electron beam irradiation, only just not with that particular name—many of us sit in front of one source for many hours a week and we call it a television. The difference between the irradiation equipment used to preserve hides and a television set is only about 1 million electron volts (1 Mev), but the principal is the same. Used on fresh cattle hides the high energy electrons kill all of the microorganisms on the hide preventing them from damaging the hide, as long as additional bacteria are prevented from coming in contact with the hide, it will be stable indefinitely.

While the advantages of this system are great, the disadvantage right now is that a new facility might cost between 5 and 7 million dollars (US) and no one wants to be the first to try it out. However, we are continuing to do research in this area and, as salt becomes a more and more difficult problem, using electron beam cured (irradiated) hides may become more and more attractive.

Gamma Radiation:

Similar to electron beam irradiation, this is another salt-free preservation method for cattle hides. In the electron beam application hides must be treated individually on an assembly line but this will facilitate grading and may indeed be a distinct advantage. Gamma irradiation, on the other hand, can be applied to hides in bulk. The procedure used to prepare the hides using either E-beam or gamma irradiation will permit hides to be taken from the packer to an existing commercial facility for treatment. This eliminates the capital investment required for electron beam preservation. The advantage initially may go to the bulk hides that can be treated for gamma irradiation.

Substitution of Potassium Chloride for Sodium Chloride:

Potassium chloride has similar physical and chemical properties to common salt, sodium chloride, but is very much different in one respect. While sodium chloride has very negative effects on the growth of plants when applied to the soil, potassium chloride is required for proper plant growth.

It is the similar properties of the two salts that allows hides to be cured with potassium chloride in the same way as sodium chloride[9,10]. We have cured hides in a paddle vat, hide processor, salt pack and in a brine raceway. In all cases the leather produced from each method of curing has been very much the same. Not only is the leather the same but the by-product of the reaction, a gallon of saturated brine from each hide, is the same. Except that this by-product can be applied to the soil of the nearest farm.

More than 4000 hides and skins have been processed with potassium chloride in the study[6] that was completed in 1987. Cattle hides, calf skins and pig skins were treated in paddle vats, processors and brine raceways. The overall results suggest virtually no difference between the quality of hides produced by this curing method compared to traditional curing with sodium chloride. However, at this time, the higher cost of potassium chloride and the limited pressure on salt in packing house effluents preclude the use of this material at this time. These economics could change rapidly in the future.

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